# Investigation of the 5n and α4n channels in the $^{20}$Ne on $^{244}$Pu reaction

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The isotope $^{259}$Rf was firstly investigated by Flerov et al. [1] in the 5n channel of the reaction $^{22}$Ne on $^{242}$Pu. Two years later Zvara et al. [2] published first ever chemistry experiments with the element Rf (Z=104) based on the products of the same nuclear reaction. These experiments were several times repeated and controversially discussed by different authors in the next two decades (for a nearly complete compilation of these discussions see [3]). Flerov et al. showed in [1] in addition to the excitation function of $^{259}$Rf the low energy part of the excitation function of $^{256}$No, which is produced in the α4n channel of the reaction $^{22}$Ne on $^{242}$Pu.

Later, only a few experiments were made to investigate nuclear reactions based on Pu and Ne [4, 5]. In our experiments we will continue the investigation of xn and αxn reactions in the region of Rf and No, which was started already in [5]. The intention is to study formation and decay properties of $^{259}$Rf and $^{256}$No in the reactions $^{244}$Pu($^{20}$Ne, 5n) and $^{244}$Pu($^{20}$Ne, α4n), respectively.

$^{259}$Rf has a half-life of (3.2±0.6) s and decays with (92±2)% probability by emission of α-particles of 8.77 MeV and 8.87 MeV [6]. $^{256}$No with a half-life of (2.91±0.05) s decays also via emission of α-particles of 8.448 MeV and 8.402 MeV [6] with a (99.47±0.06)% branching ratio. For both nuclides a spontaneous fission decay mode was reported.

A Pu target (enriched 98.6% in $^{244}$Pu) with a thickness of about 0.5 mg/cm$^2$ is in preparation at the University of Mainz via molecular plating of its nitrate on a Be-backing of 12 μm thickness.

In a first experiment at the PSI Phillips cyclotron this target will be bombarded with $^{20}$Ne$^{6+}$, at a beam energy of 113 MeV.

The recoiling reaction products are swept out of the recoil chamber using a He-carbon-gas-jet and transported to the PSI Tape System [7] within 3 s. The aerosols are collected by impaction in vacuum on the magnetic tape during 2 s and subsequently the samples are moved in front of 8 consecutive α-PIPS-detectors (450 mm$^2$ active area). For the event-by-event recording the data acquisition system described in [8, 9] will be used.

In Figure 1 the excitation function given in [1] is compared with model calculations using the HIVAP code [10, 11]. Under the described experimental conditions about 15 events of $^{259}$Rf at a cross-section of 0.6 nb will be expected within an 8 day irradiation at beam intensities of about 1.2 eμA. The use of the PSI Tape System inhibits the accumulation of long-lived spontaneously fissioning nuclides, such as $^{256}$Fm, which are produced in transfer channels of the nuclear reaction. But the outcome of the experiment also depends very much on the purity of the target material, since by-products (e.g. $^{211-214}$Po) from nuclear reactions with heavy metal impurities in the target may disturb the unambiguous identification of $^{259}$Rf and $^{256}$No. In that case a fast chemical separation as described in [12] will be necessary.

The results of this first experiment, which is conducted in August 2003, will be presented.

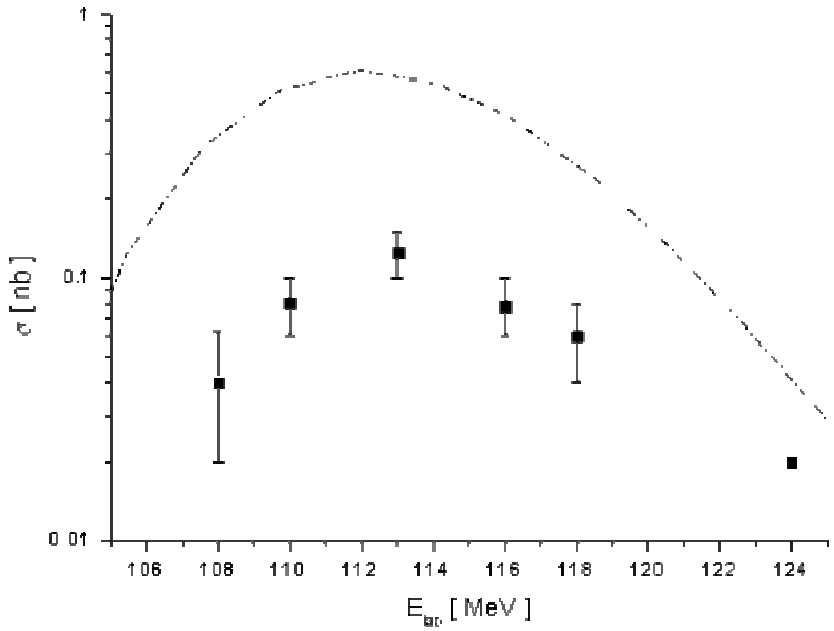


Figure 1. The cross section of $^{259}$Rf in the reaction $^{242}$Pu($^{22}$Ne, 5n). Symbols: experimental data from [1]; dotted line: model calculations using HIVAP for the reaction $^{244}$Pu($^{20}$Ne, 5n).

## References


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